PATENT SPECIFICATION

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(54) IMPROVEMENTS IN OR RELATING TO POWER TRANSMITTING MECHANISMS, AND APPLICATIONS THEREOF, NOTABLY TO HELICOPTERS

(71) We, SUD-AVIATION SOCIETE NATIONALE DE CONSTRUCTIONS AERONAUTIQUES, a French Joint-Stock Company, of 37, Boulevard de Montmorency, Paris, Seine, France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In British Patent No. 1.085.453 is claimed a mechanism for transmitting power to two members or sets of members from a common power source, characterized by the fact that it comprises three coaxial shafts which are permanently connected respectively to said common source and to said two members or sets of members and which are interconnected or disconnected in pairs through the medium of three automatic clutching and declutching devices inserted respectively between the paired shafts.

In a specific embodiment, a mechanism of this kind is associated with a pair of turbine engines and ancillary systems, the whole aboard a helicopter.

For operation of an arrangement of this kind, a control at the pilot's disposal allows the automatic drive engaging devices of the transmission mechanism to be actuated, but the pilot must first ensure that all the requirements for correct operation are met. For the control referred to controls a clutch device in a main transmission box connected to one of two turbine engines, and it is essential that the pilot adjust, by means of other controls and at clearly defined moments, the rotation speeds of the two engines to the values required to ensure smooth clutch engagement or disengagement.

The present Addition to the aforesaid British Patent No. 1 085 453 relates to improvements in the arrangement described in the aforementioned patent specification and has more particularly for its object to embody, in one and the same control, the control for effecting coupling and decoupling in said main transmission box whereby to drive the rotor or rotors of a helicopter by means of the turbine engines and drive the ancillary on-board systems, and the throttle controls of said engines.

The Addition accordingly includes a mechanism as claimed in claim 1 of British Patent No 1 085 453 including a unit comprising a coupler-decoupler which operates one of the clutching devices of the power transmitting mechanism together with means for interlinking this with the throttle levers of the common power source which is a pair of engines driving a helicopter rotor, one of said engines being capable of continuously driving ancillary systems, and one of said throttle levers being associated with said one engine, characterized by the fact that said coupler-decoupler is a coupling lever which over part of its travel moves said associated throttle lever with it, said coupling lever being constrained by a grid for guiding said levers.

In a preferred embodiment, the coupling control is associated with a monitor device enabling the pilot to be informed that the commanded operations have been executed.

In one specific embodiment, a lever block is mounted on the celing of a helicopter cockpit and the coupling lever is constrained to move in a S-like motion, the throttle levers being engaged by means of a stub.

A flexible drive of known type connects the coupling lever to a control unit which transmits the motions due to movement of the coupling lever to a drive shaft. Mounted on the control unit is a microswitch connected into the circuit of an indicator lamp on the instrument panel.

With such an arrangement, movement of the coupling lever alone allows all the required operations to be performed, includ-

ing couplings and decouplings, and increases and decreases in the fuel flows to the two engines.

An alternative embodiment of such an arrangement, designed to make the system even more reliable, includes powered means for actuating the coupling shaft, means for preparing reversal of the direction of rotation of the associated motor while the coupling lever is being moved, means for temporarily locking the coupling and throttle levers, associated with means for checking execution of the engine commands, and means for monitoring the positions reached by the levers and by the coupling and decoupling member, the whole designed to form a safeguarded system.

In this specific embodiment the actuating means is a rotary actuator of known type connected to a lever-block via an electric circuit comprising microswitches and relays at the actuator end, the latter being adapted to operate the coupling shaft by a crank and connecting-rod arrangement.

Disposed on the lever-block support is a bistable mechanical flip-flop which is activated when sensors associated with the main lever pass before it and which operates a switch for preparing for the subsequent reversing operation of the actuator.

Also disposed on the lever-block is a mechanical locking system with bolts, operated electrically at the same time as contact points for closing the actuator circuit during the locking.

Connected into the operating circuit as a whole is a time-delayer which enables the engine speeds to stabilize subsequent to actuating commands.

Similarly, the safety system includes means for preventing coupling or decoupling if one of the engines is stopped and the helicopter is in flight.

Lastly, the system includes indicator means formed, for example, by lamp indicators activated on the helicopter's instrument panel and, alongside an instrument for monitoring the engine RPM, a latchable master switch for energizing the installation.

A system as hereinbefore described makes it possible to introduce the maximum degree of automation into the coupling and decoupling operations compatible with safe and easy piloting.

The description which follows with reference to the accompanying non-limitative exemplary drawings will give a clear understanding of how the invention can be carried into practice.

In the drawings:

Figure 1 is a perspective view showing with cutaways the layout used for a control system according to the invention, as applied to a helicopter powered by two turbine engines.

Figure 2 is a perspective view showing the lever-block equipped with a flexible drive.

Figure 3 shows in partial section, on a transverse plane passing through the axis of the lever-block, the articulation end of the coupling and decoupling lever in a main transmission box.

Figure 4 is an external front view of the control unit equipped with a microswitch and mounted on the main transmission box.

Figure 5 is a sectional view through the line V-V of Figure 4.

Figure 6 is a separate perspective showing of the actuating lever of said box.

Figure 7 is a schematic portrayal, from the rear, of the displacements of the levers in the lever-block selector, the levers being in the configuration corresponding to "powerplant coupled" and full throttle on both engines.

Figures 8 and 9 show, correspondingly to Figure 7, lever configurations occurring during throttling down of one of the engines.

Figures 10 and 11 similarly show the lever configurations occurring during throttling down of the second engine, subsequent to decoupling.

Figures 12 and 13 correspondingly show the manoeuvres resulting in a limited increase in throttle opening of the first engine, with the main transmission box in the decoupled configuration, in order to cause the power required to drive the generators of the ancillary systems to be supplied by said first engine.

Figures 14 and 15 show, conversely, the manoeuvres for throttling down the first engine, followed by opening of the throttle of the second engine and coupling anew in order to resume driving of the helicopter rotor(s) by the two turbine engines.

Figure 16 shows partially only, in section, the disposition of an electric rotary actuator connected to a coupling shaft, the section being taken through the line XVI-XVI of Figure 17, which Figure 17 is an external plan view of that arrangement.

Figure 18 is a schematic rear portrayal of the selector plate on the lever-block and of the auxiliary devices associated thereto, in the configuration corresponding to coupling of the helicopter rotor and of one of the driving engines.

Figure 19 is a view corresponding to Figure 18, showing the disposition in the course of decoupling, subsequent to locking of the engine throttles.

Figure 20 is a view corresponding to Figure 18, showing the positions during decoupling of the throttle levers for minimum fuel flow to the engines.

Figure 21 shows the position of the throttles in the "ground generation" mode.

Figure 22 shows the disposition of the levers and their auxiliaries in the course of coupling, following locking of the throttles.

Figure 23 is an electrical wiring diagram of the installation.

In the form of embodiment shown more specifically in Figure 1, the decoupling system is formed by a lever-block 1 located in the forepart of the ceiling of a helicopter cockpit, and this lever-block 1 is connected through a flexible but non-extensible drive 2 of any convenient type to a decoupling control unit 3 equipped with a microswitch 4 connected into the circuit of a monitoring indicator lamp mounted on the instrument panel.

As shown in Figure 2, the lever-block 1 includes, for the purpose of guiding said levers, a curved selector grid 5 centred substantially upon the articulation axis of the levers and embodying a central S-shaped cutout 6 and, to either side thereof, two identical parallel cutouts 7 and 8, the shapes of which are more clearly shown in Figures 7 to 15.

In the cutout 6 is displaceable a lever 9 for coupling and decoupling turbines with respect to a rotor and for controlling ground generation, ie. for driving the ancillary generators off one of the turbine engines, which lever will hereinafter be referred to as the main lever. At one angled end 10 protruding through selector grid 1, the main lever carries a handle 11. Its other end is formed by a block 12 carried in an articulation clevis 13. As shown in Figure 3, the block 12 is formed, beyond the indent which surrounds the hinge pin for the lateral levers and the main lever, with an extension 14 traversed by a pin 15 the ends of which extend into the two branches forming the bottom of clevis 13. This articulation thus allows main lever 9 to move in a plane passing through an articulation axis, and to do so independently of motion about said axis. The two branches of clevis 13 receive bonded friction washers 16 through which a tubular shaft 17 common to all the levers passes.

These two branches are retained by an inner tubular spacer 18 likewise mounted on shaft 17.

A double-ended stub 22 has its ends protruding from both sides of the block 12, which ends are suitably shaped to cooperate with the slots to be described hereinbelow.

On either side of the clevis 13, with suitable spacers bearing on the washer 16, are two levers 23 and 24 which are the throttle levers of the two turbine engines, respectively. At the foot of lever 23 are formed two superimposed slots 25 and 26, but only one slot 27 in the lever 24. This latter slot is not entirely visible in Figure 2 but appears in Figure 7 *et seq.*

The coupling control proper is a flexible but inextensible drive 28 slidably mounted in at least two ball-jointed guides 29. At both its ends the drive 28 is fixed to clevis-forming ferrules 32. Adjacent the lever-block, ferrule 32 is hingedly connected to a lug 30 integral with clevis 13. The other ferrule is connected to a coupling lever to be described hereinbelow.

As shown in Figures 4 and 5, the coupling and decoupling control system 3 includes a securing flange 33 secured by nuts 34 to a reduction gear cover 35 attached to the lefthand engine, a laminated packing shim 36 being interposed therebetween. Flange 33 is formed with a tubular extension through which is slidable a draw-bar 37 terminating in an eye 19 through which extends a pin 20 for connecting it with a clevis 21 on the end of a coupling and decoupling control shaft 38 (of the same functions as shafts 28 or 53 in British Patent Specification No. 1 085 453). Shaft 38 is equipped with a return spring 39 which bears at one end against a ridge 40 on said shaft and reacts at its other end against a washer 41 which in turn bears against the end of a spacer 42 driven into the bore of a tubular extension 35*a* of cover 35, which spacer forms a guide for shaft 38.

Seals 43, 44, 45 and 46 ensure leaktightness respectively between control shaft 38 and spacer 42 and between spacer 42 and cover 35.

A rod 47 is fixed to draw-bar 37 and passes through a hollow part at the end thereof, where it is secured by a ring 48 located inside this hollow part, said ring being retained by a circlip 49. The end-section of ring 48 bears on rod 47 between a head 47*a* and a midway shoulder formed on said rod. The head 47*a* and this shoulder can be moved to cause the rod 47 to move axially with respect to the tubular extension of flange 33, along longitudinal openings 50 formed in said tubular extension.

A coupling and decoupling lever 51 is rigid with a bush 51*a* pivotally mounted on the tubular extension of flange 33. This bush covers the head 47*a* of rod 47 but allows the midway shoulder thereon to pass through an opening 52, one of the sides of which forms a helicoid ramp 52*a*. The opening 52 as shown in Figure 6 is shaped substantially as a triangular cutout, one of its sides adjoining the ramp 52*a* being axially oriented. A circlip 53 retains the bush 51*a* on the tubular extension of flange 33, at one end, retention at the other end being effected by a ridge on said extension.

The other end of rod 47 is formed with a head 47*b* capable of cooperating with the movable element of a microswitch 54. This

microswitch is inserted into the feed circuit of a warner-repeater device in respect of the position of shaft 38, an example being a lamp indicator mounted on the helicopter's instrument panel.

The mechanism hereinbefore described functions as follows:

Through actuation of main lever 9 and via the drive 28, rotation of lever 51 causes axle 47 to advance along helicoid ramp 52*a*, thus also causing shaft 38 to move back in the direction tending to compress spring 39. In reverse actuation, rod 47 is left free and forward motion of shaft 38 is caused solely by relaxation of spring 39.

As will be notably apparent from Figure 7 *et seq*., if the coupled situation between rotor and motors is regarded, for the explanation of the present invention as the starting configuration in the main transmission box, corresponding to relaxation of spring 39, the two throttle levers 23 and 24 will be in their full-throttle positions, i.e. in their uppermost positions in selector grid 5, inside their respective slots 7 and 8. The coupling or main lever 9 is also in its upper position, as shown in Figure 7. Lever 51 is in the position shown in Figures 4 and 6, with the midway shoulder on axle 47 located at that end of helicoid ramp 52*a* which is nearest the axially directed edge of opening 52 (opposite to said ramp 52*a*).

In order to effect the decoupling manoeuvre, resulting in uncoupling of the helicopter rotor from one of the engines (the lefthand engine, say) the following operations are required:

— Reduce the lefthand engine throttle opening

— Effect decoupling

— Reduce the righthand engine throttle opening

— Partially increase the lefthand engine throttle opening after decoupling, to allow this engine to continue to drive the ancillary systems, as described in British Patent Specification No. 1 085 453.

With the system described hereinbefore, these operations are performed automatically by merely moving main lever 9 along the cutout 6 in selector 5.

As notably shown in Figure 8, the pilot can move lever 9 from the position of midway engagement at the bottom of the short upper branch of cutout 6 into a position opposite the adjoining vertical branch of that cutout, which in turn causes one of the ends of stub 22 to penetrate into the upper slot 25 in lever 23.

As shown in Figure 9, the descent of lever 9 along this first vertical branch carries lever 23 towards the end of its guiding slot 7, thereby reducing the fuel flow to the lefthand engine.

As is clearly shown in Figure 10, main lever 9 is then caused to travel along the midway horizontal branch of cutout 6, whereby the end of stub 22 which was theretofore operative leaves slot 25 and its other end penetrates into the low slot 27 of the opposite lever 24.

As may be seen from Figure 11, downward movement of lever 9 through the second vertical branch of cutout 6 simultaneously lowers the lever 24, which achieves both decoupling, through pivoting of lever 51 and withdrawal of shaft 38, and a reduction of the righthand engine throttle opening.

As shown in Figure 12, lever 9 is caused to travel along the lower horizontal branch of cutout 6, thus disengaging the second end of stub 22 from slot 27 and rendering its first end operative in slot 26 of lever 23. As Figure 13 shows, moving the lever 9 upwards through the third short vertical branch of cutout 6 slightly increase the fuel flow to the lefthand engine, thus giving the latter a power setting adequate for driving the ancillary generators without driving the helicopter rotor(s).

At the same time as uncoupling occurs, the head 47*b* of axle 47 actuates microswitch 54 and lights up the corresponding lamp indicator on the instrument panel, and this lamp remains lit for the entire period during which the ancillary generators are being driven by the lefthand engine (helicopter rotor not driven), i.e. during the "ground generation" configuration.

In order to cause the rotor to be driven by the engines once more, the reverse operations must be performed by means of a lever 9 alone, causing fuel to be fed once more to the righthand engine with the lefthand engine idling. The rotor is then speeded up by the righthand engine. This makes it possible to couple the rotor to the lefthand engine under the action of spring 39. The stub 22 of lever 9 resumes its position in the upper slot 25 of lever 23, enabling the latter to be returned to its full-power position.

The lamp indicator is extinguished as soon as coupling takes place.

It is to be noted that in the coupled position shown in Figure 7 the pilot is free to choose the throttle openings by means of freely movable levers 23 and 24, the stub 22 having its two ends free of the lateral levers 23 and 24.

In an alternative embodiment of electrically actuated clutching and declutching control shown in Figures 16 and 17, a rotary

electric actuator 101 which operates by rotation through a quarter-turn is connected through a crank 103 to a connecting-rod 102 to form an assembly contained in a housing 104. This housing is attached to a slideway 106 for guiding the end of a shaft 105 to which the rod 102 is articulated.

As described in British Patent Specification No. 1,085,453 (see more particularly Figure 2 of said specification and the corresponding description) the other end of shaft 105 is rigid with a sliding ring 107 traversed by a pin 108 rigidly connected to a sleeve which, through the agency of rollers 109 retained in a cage 110, causes coupling or uncoupling of a drive hub 111 and a hollow shaft 112.

The arrangement shown in Figures 18 to 22 in respect of the lever-block is similar to that described with reference to Figure 2 of the present specification and includes, in a selector for guiding the movements of the coupling and decoupling lever and the throttle levers of both engines, an S-shaped central cutout 113 through which is movable a coupling and decoupling lever 114 (alternatively termed "ground generation lever" or "main lever") bearing a transverse stub 115. On either side of cutout 113 are two identical parallel slots 116 and 117 for respectively guiding throttle levers 118 and 119. Lever 118 is formed with a slot 120 and lever 119 with two slots 121 and 122, whereby to enable levers 118 and 119 to be actuated in succession by the ends of stub 115 while lever 114 is moving along cutout 113.

The lever-block includes a bistable mechanical flip-flop 123 shown in highly schematice fashion in the drawings, the moving element of which is actuated by contact studs 124 and 125 located along the path of lever 114 through cutout 113. Via a lever 126, flip-flop 123 is associated with a reversing microswitch having a plate 127 designed to confirm electrically and irreversibly an actuation command, in either the coupling or the decoupling sense, by means of said flip-flop.

Additionally provided on the lever-block is a magnetically operated locking unit which includes a solenoid 128 the movable core of which is connected to a beam-lever 129, and the ends of this beam-lever are connected to bolts 130 and 131 which in their retracted positions are located adjacent the paths of levers 118 and 119, and in their operative positions lie squarely in said paths. These bolts engage ridges (not shown) formed on the levers when the latter are appropriately positioned. Bolt 130 is adapted to lock lever 118 and bolt 131 to lock lever 119.

Thus the two throttle levers 118 and 119 can be locked in their respective positions during the gas-turbine RPM stabilizing phase and during the automatic coupling or uncoupling manoeuvre. It is to be noted that solenoid 128 must be kept energized during this phase.

The magnetic core of the solenoid is additionally connected to a switching contact 132 the function of which will become apparent hereinafter.

As shown in Figure 23, the electrical installation shown diagrammatically thereon is configured to correspond to the situation when the helicopter is in flight, i.e. with a lift rotor coupled to the engines. It includes, in addition to the switches and the solenoid referred to precedingly, a functional system ensuring maximum reliability for the control system and preventing accidental operation thereof under any circumstances whatsoever, notably in flight.

This installation includes a main supply bus 133, to which a circuit-breaker contact 134 is connected.

The foolproof safeguards include an earthed contact blade 135 actuated by lever 118 when the latter is in its full-throttle position, as shown in Figure 18. The operative contact of blade 135 is connected to the relay 136 of a contactor, which is additionally connected to the moving plate of a master switch 151 to be described hereinbelow. Similarly, a contact plate 137 is connected to a source of direct current via a positive pole, and this plate is actuated by the lever 119 when the latter is in its minimum-throttle position (Figures 20 and 22). The operative contact of plate 137 is connected, via an interposed diode, to the coil 138 of a contactor, the other end of which coil is connected to the operative contact of a plate 153 (to be described hereinafter) and to two diodes to which further reference will be made later.

A sensing device 139 is mechanically connected to the shaft 140 of one turbine engine and a sensor 141 is connected to the shaft 142 of the other turbine engine. These sensors are electrically connected to an electronic frequency comparator unit 143 of known type, which is in turn connected to a relay coil 144. The other end of coil 144 is connected to a conductor 144*a* which interconnects one output from unit 143 to the output end of coil 138 via one of said diodes. This output from coil 144 is also connected via a time-delay device 148 to a relay coil 147 the opposite input of which is connected to the operative contact of the plate 441, which plate is actuated by coil 144 and connected to a wire 144*b* extendin, *inter alia*, to a supply input of unit 143.

Plate 441 is additionally connected to the resting contact of a plate 451 operated by a relay coil 145. The input to coil 145

and the plate 451 are parallel-connected to the operative contact of a plate 381 actuated by the coil 138. Plate 381 is connected to the operative contact of a plate 361 actuated by the coil 136, and this plate and the input of said coil are connected to master switch plate 151.

The output end of coil 145 is connected via a diode 145*a* to one of the operative contacts of a plate 1466 which is actuated by a bellows-capsule 146*a* which senses the lubricating oil pressure in the first engine. This contact is connected to a diode 146*b*, itself connected to an indicator on a fault panel. The other operative contact of plate 146 is earthed.

A contact plate 471 is connected to master switch plate 151 and its operative contact is connected to said plate 127 of the reversing microswitch hereinbefore mentioned.

Plate 151 is connected likewise to the operative contact of a plate 491 belonging to a power relay 149. Plate 491 is connected to solenoid 128, which is shunted by a diode 128*a*. The output from solenoid 128 is connected to the input end of coil 149, the output end of which is connected to the resting contact of a plate 501 actuated by a coil 150.

The series-wound actuator motor 101 comprises a rotor R connected, on the one hand, to the operative contact of plate 132 and, on the other, to the common point of two stator windings 101*a* and 101*b*. The ends of these two windings are connected to the resting contacts of two plates belonging to double changeover switches. The latter include a plate 154*a* connected to the resting contact of plate 127. The operative contact of plate 154*a* is connected to the input end of coil 150, the output of which is earthed. An opposite plate 157*a* is connected to the operative contact of plate 127 and its operative contact is also connected to the input end of coil 150. A plate 154*b* actuated simultaneously with plate 154*a* is connected to the resting contact of a plate 157*b* which is earthed and which is actuated at the same time as plate 157*a*.

The resting contact of plate 154*b* is connected to an indicator light 156 of the manoeuvre under way, and its operative contact is connected to a coupled-state indicator lamp 155.

The operative contact of plate 157*b* is connected to a decoupled-state indicator lamp 158.

The lamp 155 is connected through a wire 161 to the operative contact of master-switch plate 151, the resting contact of which is earthed.

The two lamps 156 and 158 are parallel-connected by a conductor 159 to a conductor 160 which is connected both to the circuit-breaker plate 134 and to a plate 152 actuated mechanically by lever 114 when the latter is in the coupling position and the levers 118 and 119 are in their full throttle positions, plate 152 having a resting contact connected to conductor 161.

The above-described arrangement functions as follows:

If it is desired to effect a decoupling, the plate 135 associated with throttle lever 118, being in its operative position, provides a check that it is indeed in its maximum fuel flow position and that relay 136 is energized and its plate 361 in its operative position. Through plate 137 being in its operative position a check is provided that lever 119 has indeed been moved, by the descent of lever 114 (Fig. 19), to the position of minimum fuel flow to the second engine, and coil 138 fetches plate 381 into its operative position.

The unit 143 absolves the pilot from the need to monitor engine RPM values on tachometers, in that, when the RPM figures have reached appropriate relative values, unit 143 energizes coil 144 with current issuing from resting plate 451, via plate 381, plate 361 and plate 151 (all operative), plate 152 (which moves to its resting position as soon as lever 114 is moved) and via operative circuit-breaker plate 134, the whole off bus 133 with return to earth via diode 138*a* and operative plate 153, the latter being responsive to compression of a landing gear shock-absorber when the helicopter is on the ground.

Energization of coil 144 closes plate 441 and feeds the coil 147 via a time-delay device 148, said plate being energized by conductor 144*b* and being in its earthing position via diode 138*a* and plate 153. Closure of plate 471 allows plate 127 and hence actuator 101 to be energized.

It should be noted that operation as above is prevented in flight through opening of plate 153.

It is likewise prevented if the first engine is shut off, i.e. if its oil pressure is insufficient, thus activating plate 146 and hence energizing the coil 145 which opens the plate 451 and thereby cuts off the supply to conductor 144*b*. This prevents, in the engine shut-off condition, any risk of the power transmission mechanism having to take-up with the damage this would entail to the power transmission box driving torque when the second engine is idling.

The time-delay 148 makes it possible to wait for possible engine RPM hunting effects to be damped out after the levers 118 and 119 have been moved into suitable positions.

In all cases the magnetic locking mechanism formed by the bolts 130 and 131 and activated by the solenoid 128 immobilizes

all the levers so long as the power relay 149 is energized, i.e. so long as relay 150 remains operative, or in other words so long as the plates 154*a* and 157*a* are spaced from their contact points while the rotor R is revolving.

Further, the master switch 151 and its latch are at the pilot's disposal, to indicate to him that the electrical installation as a whole is energized, or de-energized and earthed, as shown in Figure 23.

As soon as lever 114 has released plate 152, indicator lamp 155 is energized via the wire 161, with return to earth via plates 154*b* and 157*b*.

As soon as the above safeguards have operated, solenoid 128 is energized and the bolts 130 and 131 are positioned as shown in Fig. 19. Contact 132 is closed and the actuator 101 operates in the sense producing the required decoupling.

As soon as the actuator operates, the plate 154b leaves its operative contact and moves against its resting contact to light up the indicator lamp 156 of the manoeuvre under way.

Immediately upon activation also, plate 154*a* moves to its inoperative position to prepare the circuit of coil 101*a*.

At the end of the manoeuvre the plate 157*b* leaves its resting contact and touches its operative contact, thus extinguishing the lamp 156 (which, if it remained lit, would indicate a fault in both manoeuvring senses) and lighting the indicator lamp 158 of the decoupled state.

At the end of the manoeuvre, plate 157*a* opens and breaks the circuit of coil 101*b*, causing the actuator 101 to stop. As soon as plate 157*a* has reached its operative contact, coil 150 is energized and opens its contact 501. Coil 149 becomes inactive and the plate 491 open the circuit of solenoid 128, causing plate 132 to move to its resting position. At the same time, as shown in Fig. 20, the bolts 130 and 131 retract, with the former releasing lever 118. This allows lever 114 to be moved down to idle the first engine. Passage in front of the stud 125 causes the latter to retract, whereby flip-flop 123 switches from its first stable position to its second stable position and fetches the plate 127 againt its second contact.

Movement of lever 114 can then be continued so that it engages lever 119 through cooperation of stub 115 with the second slot 121 in lever 119. As it is carried up into the corresponding portion of cutout 113 (Fig. 21), lever 119 returns to a position in which the second engine is on partial throttle for driving the ancillary systems. In this configuration the plate 137 is returned to its resting position. All the safety relays are inoperative, including relay 136 the supply contact 135 of which was opened as soon as lever 118 could be released from latching bolt 130. Indicator lamp 158 remains lit.

Conversely, in order to effect a coupling, the lever 114 is first moved to the bottom of cutout 113. This causes the second engine to revert to idling, and plate 137 is moved to its operative position once more. Having thus released lever 119, the lever 114 engages the opposite lever 118 and the two move together into the midway position in cutout 113 (Fig. 22). Plate 135 is in its operative position. Relay 136 is energized once more, and relay 138 is also energized if the landing gear shock-absorber is compressed and contact 153 closed. The first engine reverts to full throttle.

The safety circuits then react as hereinbefore described, including the unit 143, and actuator 101 is energized on coil 101*a* and rotates in the opposite direction, thus effecting the coupling, which occurs in the indicated reversed order: extinction of lamp 158, transient ignition of lamp 156, ignition of lamp 155.

The end of the actuator's travel causes contact 501 and then contact 491 to open, thus deactivating solenoid 128 and retracting the bolts 130 and 131 and allowing the levers 114 and 119 to continue their movement, resulting in a return to full throttle on the second engine, with, in the course of movement of lever 114, retraction of stud 124, switching of flip-flop 123 with reversal of plate 127, followed, at the end of travel, by opening of plate 152 (which restores the entire system to the inoperative configuration marked by extinction of coupling-state indicator 155, with ultimate deactivation by opening of plate 151). The master switch 151 can then be opened, thus indicating to the pilot that the entire installation is no longer energized but is earthed to the frame.

WHAT WE CLAIM IS:—

1. A mechanism as claimed in claim 1 of British Patent No 1085453 including a unit comprising a coupler-decoupler which operates one of the clutching devices of the power transmitting mechanism together with means for interlinking this with the throttle levers of the common power source which is a pair of engines driving a helicopter rotor, one of said engines being capable of continuously driving ancillary systems, and one of said throttle levers being associated with said one engine, characterized by the fact that said coupler-decoupler is a coupling lever which over part of its travel moves said associated throttle lever with it, said coupling lever being constrained by a grid for guiding said levers.

2. A mechanism according to claim 1 characterized by mechanical interlockings between said coupling lever and said throttle

levers effected in succession, a first interlocking uniting the coupling lever with the throttle lever of the first engine driving the ancillary systems, and reducing the throttle opening of that first engine prior to decoupling and thereafter reducing the throttle opening of the second engine subsequent to decoupling and then partly increasing the throttle opening of the first engine.

3. A mechanism according to claim 2, characterized by the fact that said throttle levers have parallel paths and the coupling lever has an undulating path, the respective paths being defined by two parallel cutouts and an S-shaped cutout formed in said grid.

4. A mechanism according to claim 3, characterized by the fact that the coupling lever is pivotally mounted on a shaft common to the three levers by means of an articulation having an axis perpendicular to the common shaft, said coupling lever having a transverse engagement stub the ends of which reach, on either side of said coupling lever, an upper slot in the throttle lever of the ancillary systems driving engine, and thereafter a lower slot in the throttle lever of the second engine, before reaching a lower slot in the throttle lever of the first engine.

5. A mechanism according to claim 1, characterized by the fact that the coupling lever actuates, via a lever, a moving element having a slot engaged by a stud, said slot having an inclined ramp for effecting decoupling by cooperation between the inclined ramp and the stud.

6. A mechanism according to claim 1, characterized by a microswitch connected into the electric circuit of an indicator mounted on the instrument panel of the helicopter.

7. A mechanism according to claims 1 to 6, characterized by the fact that the levers are positioned on the ceiling of the cockpit of said helicopter with a flexible mechanical drive extending therefrom.

8. A mechanism according to claim 1, characterized by a powered device including an associated coupling actuator motor for actuating a coupling and decoupling shaft for the rotor, said mechanism also having means for preparing for reversal of the direction of rotation of the associated coupling actuator motor, said preparation means being activated during the displacements of the coupling and decoupling lever, means for temporarily blocking the throttle levers and hence the coupling and decoupling lever, and means for monitoring the positions reached by said levers and said coupling actuator motor.

9. A mechanism according to claim 8, characterized by the inclusion of means for verifying execution of the commanded changes of engine speed.

10. A mechanism according to claim 8, characterized by the fact that it includes an electric rotary actuator of a known type operating through a quarter of a turn and connected to said levers through electrc circuitry which includes microswitches and relays on the actuator side and microswitches on the lever side, and monitoring indicators in the cockpit.

11. A mechanism according to claim 10, characterized by the fact that the levers are associated with a bistable mechanical flip-flop actuated by the passage of the main coupling and decoupling lever past- or - across associated sensors, said flip-flop being connected to a changeover switch for preparing a reversal of the direction of rotation of the actuator motor when the actuator is next operated.

12. A mechanism according to claims 9 and 10, characterized by the fact that it includes means for mechanically locking the levers with bolts moved into the paths of the engine throttle levers, said locking means being connected to electromagnetic positioning means and being electrically activated at the same time as a contact which makes the feed circuit to said actuator for the duration of the locked state.

13. A mechanism according to any one of claims 10 to 12, wherein a time-delay means is integrated into a sequence of safety relays in order to allow the engine speeds to stabilize following control commands.

14. A mechanism according to claim 13, including, in addition to the time delay means, an engine rotation speed comparator.

15. A mechanism according to any one of claims 10 to 14, including means for interdicting operation of the actuator if one of the engines is shut off.

16. A mechanism according to any one of claims 10 to 15, wherein a contact for interdicting operation of the actuator is connected to one of the suspension members of the landing-gear.

17. A mechanism according to claim 13 as dependent on claim 10, including a circuit breaker connected into the electric power supply to the safety and operating circuits, and a master switch which in its

off position earths the entire installation to the airframe.

18. A mechanism as hereinbefore described with reference to and as represented in Figures 1 to 16 of the accompanying drawings.

19. A mechanism as hereinbefore described with reference to and as represented in Figures 17 to 23 of the accompanying drawings.

SUD-AVIATION SOCIETE NATIONALE DE CONSTRUCTION AERONAUTIQUES

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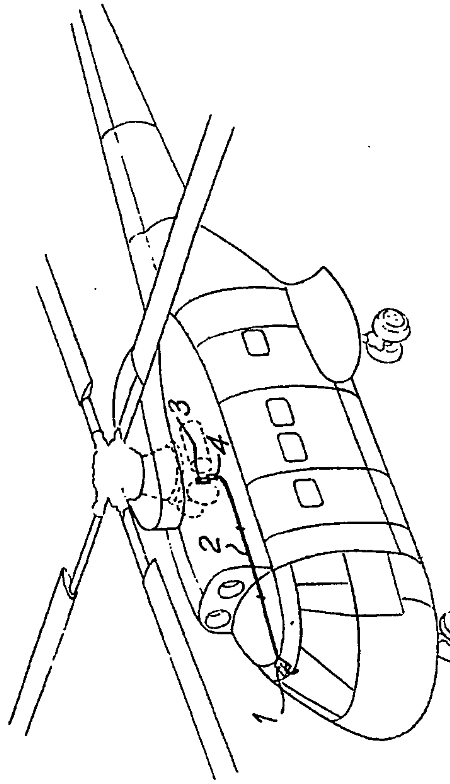

Fig. 1.

1291271 COMPLETE SPECIFICATION

10 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

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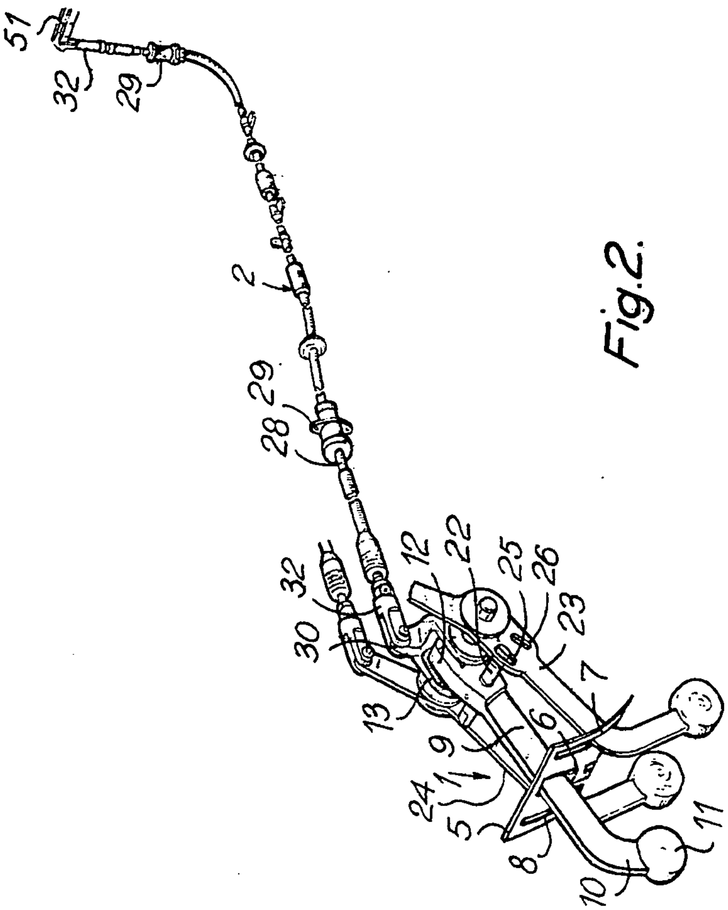

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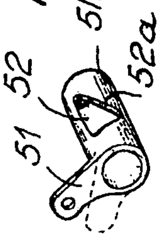

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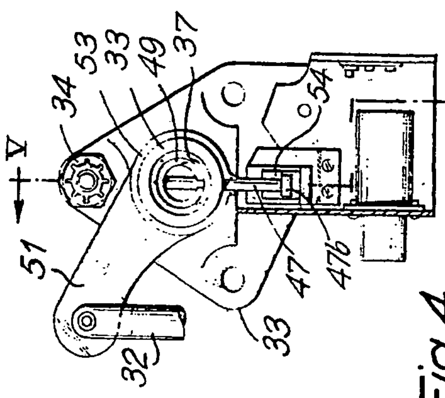

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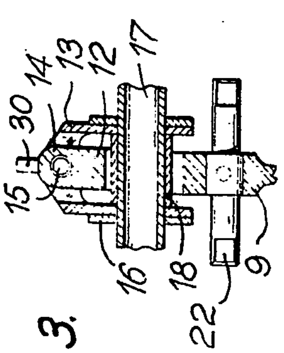
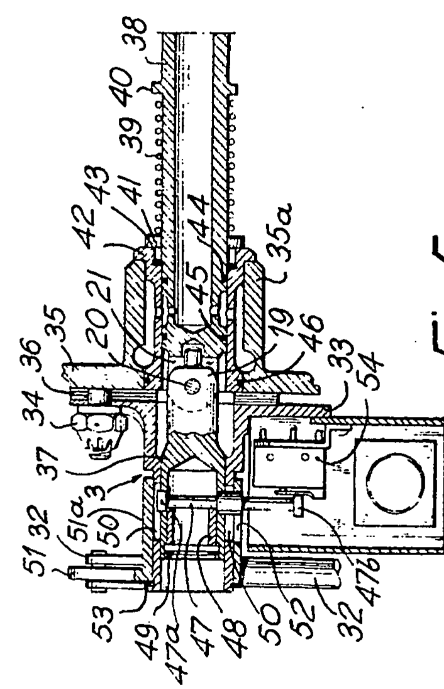


Fig. 3.



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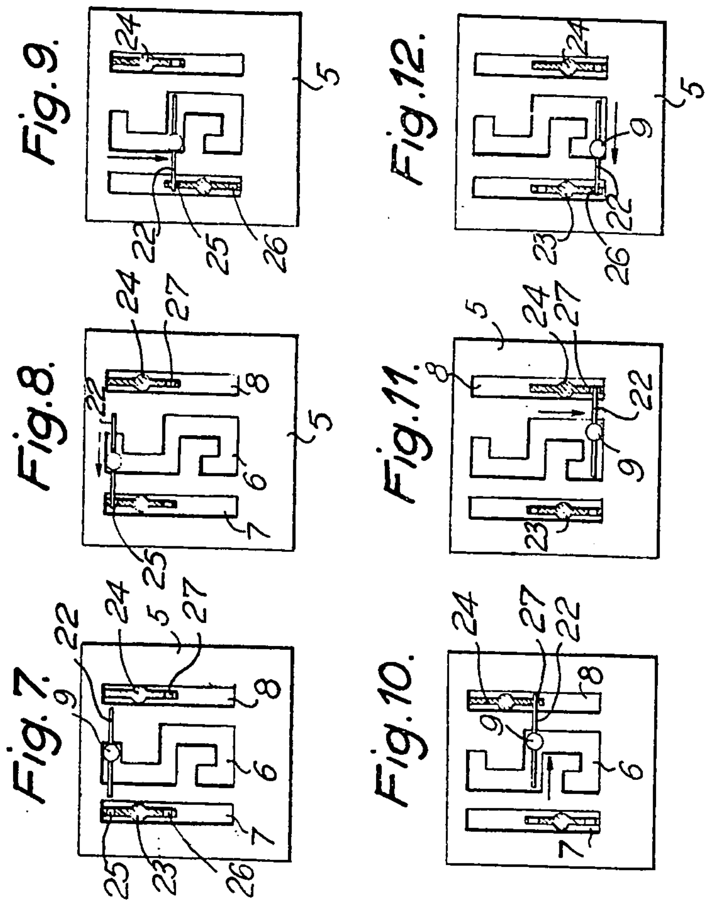

Fig. 7.
Fig. 8.
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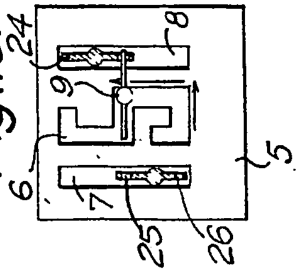
Fig.15.



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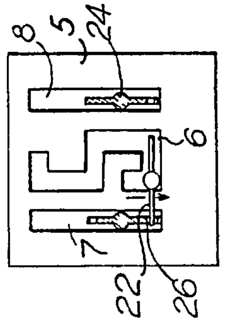

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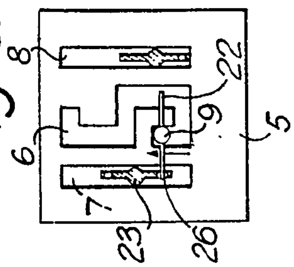

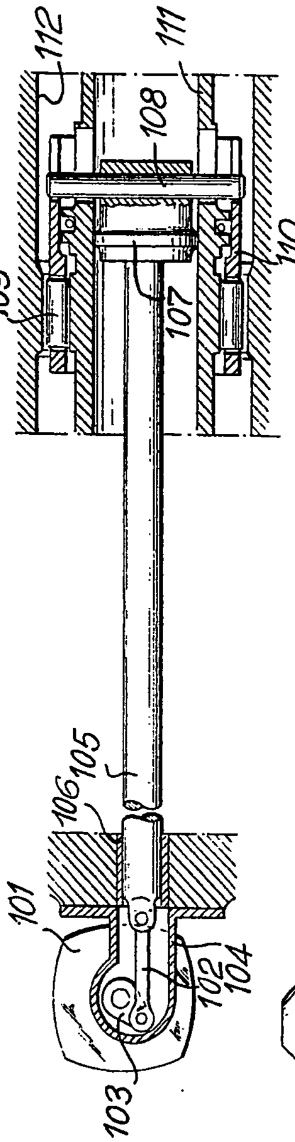
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Fig.16

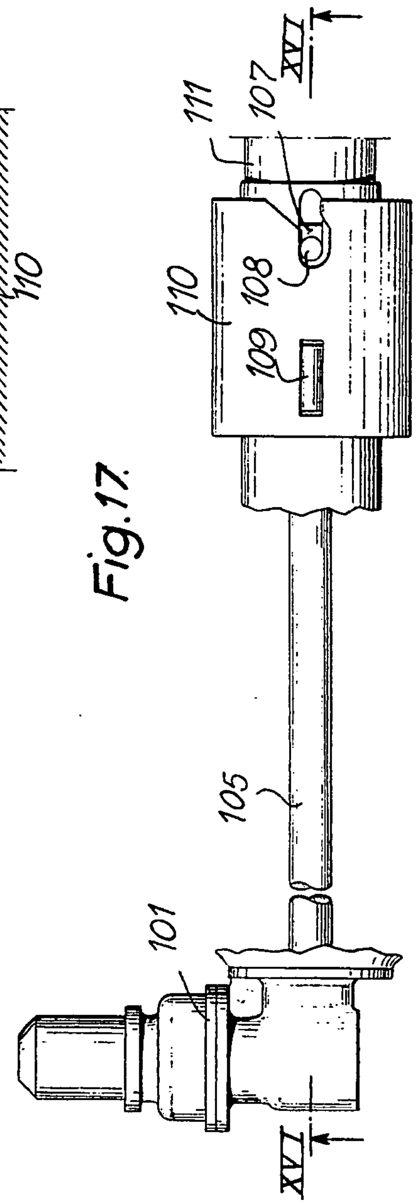
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Fig.17

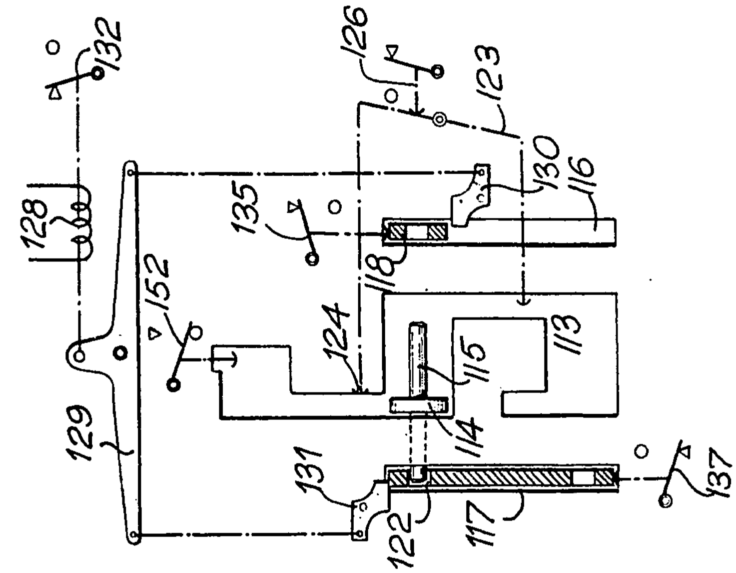
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Fig.19

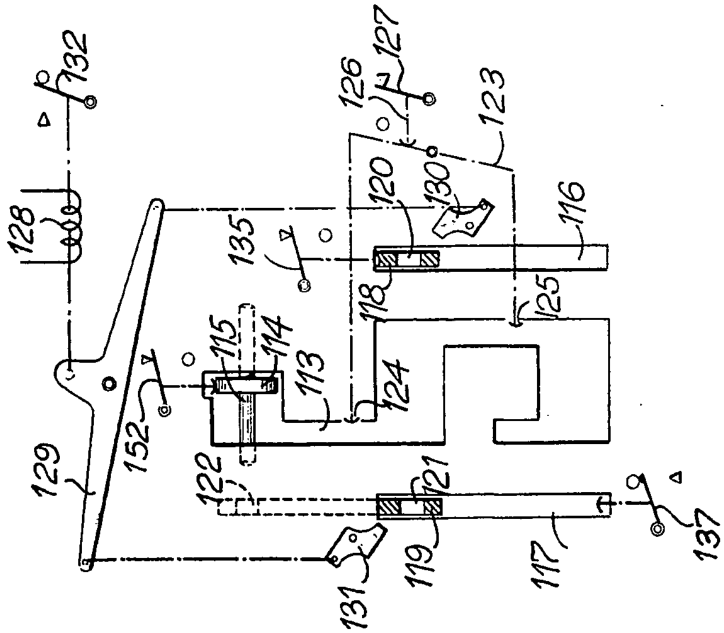
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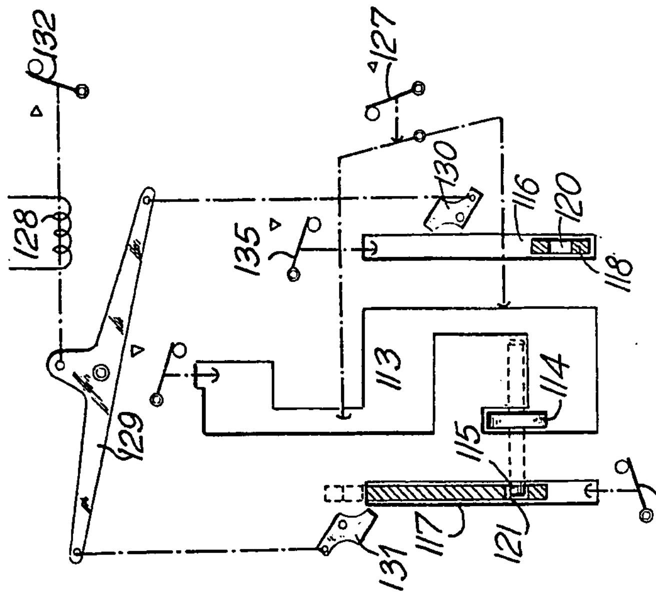
Fig.18.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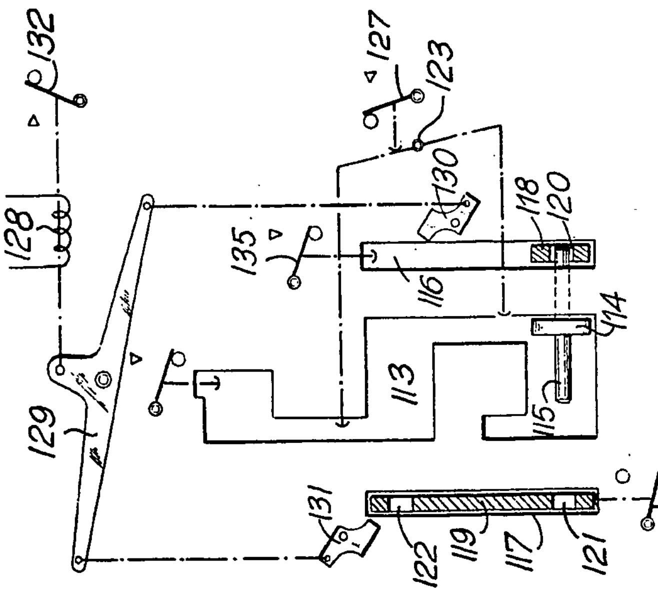
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Fig.20

Fig.22.

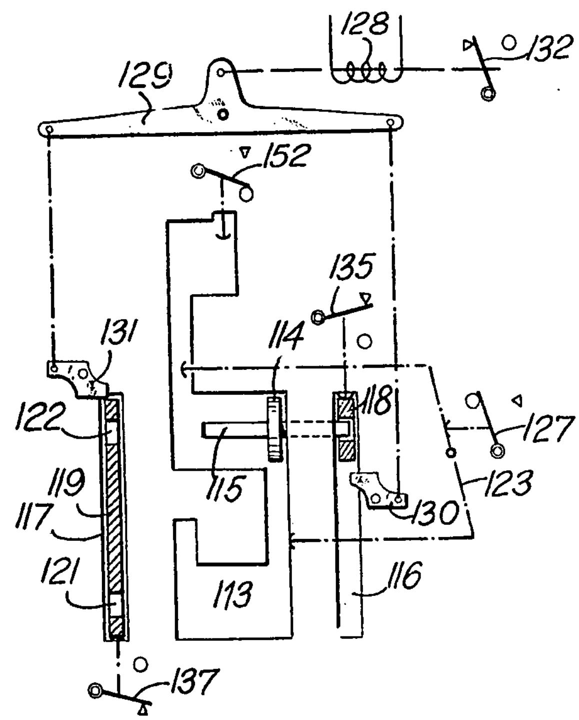
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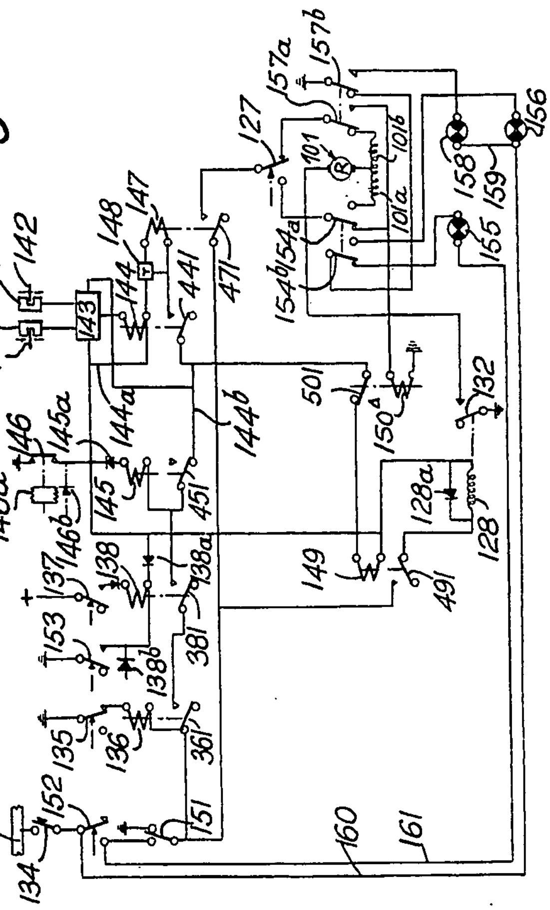
Fig.23.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